

Ch 4. Introduction to Recursion

Recursive functions

- A recursive function
 - A function that calls itself, either directly, or indirectly (through another function).

- Example: factorial

$$\text{Let } f(n) = n! = n * (n - 1) * (n - 2) * \dots * 1$$

- A recursive definition of the factorial function

$$f(0) = 0! = 1$$

$$f(1) = 1! = 1$$

$$f(n) = n! = n * (n - 1)! = f(n - 1)$$

Iterative Function Factorial

```
int main()
{
    int n;
    cout << "Enter a positive Integer: ";
    cin >> n;
    cout << n << "! = " << f( n ) << endl;
}

int f( int n )
{
    int result = 1;
    for( int i = 2; i <= n; i++ )
        result *= i;
    return result;
}
```

$$f(n) = n! = n * (n - 1) * (n - 2) * \dots * 1$$

Iterative Function Factorial

```
int main()
{
    int n;
    cout << "Enter a positive Integer: ";
    cin >> n;
    cout << n << "! = " << f( n ) << endl;
}

int f( int n )
{
    int result = 1;
    for( int i = n; i >= 2; i-- )
        result *= i;
    return result;
}
```

$$f(n) = n! = n * (n - 1) * (n - 2) * \dots * 1$$

Recursive Function Factorial

```
int main()
{
    int n;
    cout << "Enter a positive Integer: ";
    cin >> n;
    cout << n << "! = " << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return          ;
}
```

$$f(n) = 1 \quad \text{for } n \leq 1 \quad (n! = 1)$$

$$f(n) = n * f(n - 1) \quad \text{for } n > 1 \quad (n! = n * (n - 1)!)$$

Recursive Function Factorial

```
int main()
{
    int n;
    cout << "Enter a positive Integer: ";
    cin >> n;
    cout << n << "! = " << f( n ) << endl;
}
```

```
int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return n * f( n - 1 );
}
```

$$f(n) = 1 \quad \text{for } n \leq 1 \quad (n! = 1)$$

$$f(n) = n * f(n - 1) \quad \text{for } n > 1 \quad (n! = n * (n - 1)!)$$

```

int main()
{
    int n;
    cout << "Enter a positive Integer: ";
    cin >> n;
    cout << n << "! = " << f( n ) << endl;
}

```

1

```

int f( int n )
{
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 );
}

```

```

int main()
{
    int n;
    cout << "Enter a positive Integer: ";
    cin >> n;
    cout << n << "! = " << f( n ) << endl;
}

```

2

```

int f( int n )
{
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 );
}

```

1


```

int main()
{
    int n;
    cout << "Enter a positive Integer: ";
    cin >> n;
    cout << n << "! = " << f( n ) << endl;
}

```

3

```

int f( int n )
{
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 );
}

```

2

```

int main()
{
    int n;
    cout << "Enter a positive Integer: ";
    cin >> n;
    cout << n << "! = " << f( n ) << endl;
}

```

4

```

int f( int n )
{
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 );
}

```

3

```

int main()
{
    int n;
    cout << "Enter a positive Integer: ";
    cin >> n;
    cout << n << "! = " << f( n ) << endl;
}

```

5

```

int f( int n )
{
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 );
}

```

4

```
#include <iostream>
using namespace std;

int f( int n );

int main()
{
    int n = 4;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return n * f( n - 1 );
}
```

```
int f( int 4n ) {  
    if( n <= 1 ) return 1;  
    else  
        return n * f( n - 1 ); }
```

```
int f( int n ) {  
    if( n <= 1 ) return 1;  
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int f( int 4n ) {  
    if( n <= 1 ) return 1;  
    else  
        return n * f( n - 1 ); }  
3
```

```
int f( int n ) {  
    if( n <= 1 ) return 1;  
    else  
        return n * f( n - 1 ); }
```

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int f( int n ) {  
    if( n <= 1 ) return 1;  
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```

```
int f( int n ) {  
    if( n <= 1 ) return 1;  
    else  
        return n * f( n - 1 ); }
```

```
int f( int 4n ) {  
    if( n <= 1 ) return 1;  
    else  
        return n * f( n - 1 ); }  
3
```

```
int f( int 3n ) {  
    if( n <= 1 ) return 1;  
    else  
        return n * f( n - 1 ); }  
2
```

```
int f( int 2n ) {  
    if( n <= 1 ) return 1;  
    else  
        return n * f( n - 1 ); }
```

```
int f( int n ) {  
    if( n <= 1 ) return 1;  
    else  
        return n * f( n - 1 ); }
```

```
int f( int 4n ) {  
    if( n <= 1 ) return 1;  
    else  
        return n * f( n - 1 ); }  
3
```

```
int f( int 3n ) {  
    if( n <= 1 ) return 1;  
    else  
        return n * f( n - 1 ); }  
2
```

```
int f( int 2n ) {  
    if( n <= 1 ) return 1;  
    else  
        return n * f( n - 1 ); }  
1
```

```
int f( int 1n ) {  
    if( n <= 1 ) return 1;  
    else  
        return n * f( n - 1 ); }
```



```

int f( int 4n ) {
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 ); }
3

```

```

int f( int 3n ) {
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 ); }
2

```

```

int f( int 2n ) {
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 ); }
1

```

```

int f( int 1n ) {
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 ); }
1

```

```

int f( int 4n ) {
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 ); }
3

```

```

int f( int 3n ) {
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 ); }
2

```

```

int f( int 2n ) {
    if( n <= 1 ) return 1;
    else
        return n * 2f( n - 1 ); }
1 1

```

```

int f( int 1n ) { 1
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 ); }

```

```

int f( int 4n ) {
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 ); }
3

```

```

int f( int 3n ) {
    if( n <= 1 ) return 1;
    else
        return n * 6f( n - 1 ); }
2 2

```

```

int f( int 2n ) {
    if( n <= 1 ) return 1;
    else
        return n * 2f( n - 1 ); }
1 1

```

```

int f( int 1n ) {
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 ); }
1

```

```

int f( int 4n ) {
    if( n <= 1 ) return 1;
    else
        return n 24* f( n - 1 ); }
           6   3

```

```

int f( int 3n ) {
    if( n <= 1 ) return 1;
    else
        return n 6* f( n - 1 ); }
           2   2

```

```

int f( int 2n ) {
    if( n <= 1 ) return 1;
    else
        return n 2* f( n - 1 ); }
           1   1

```

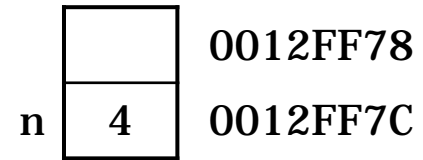
```

int f( int 1n ) {
    if( n <= 1 ) return 1;
    else
        return n * f( n - 1 ); }

```



```
int main()
{
    int n = 4;
    cout << f( n ) << endl;
}
```



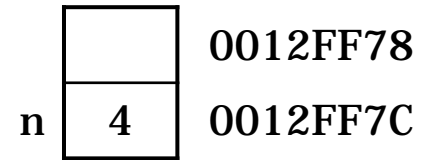
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{
    if( n <= 1 ) return 1;
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```

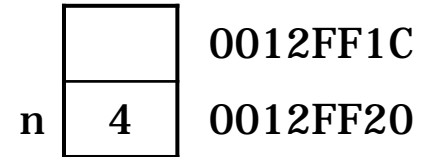
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int f( int n )
{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
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{
    if( n <= 1 ) return 1;
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```

```
int main()
{
    int n = 4;
    cout << f( n ) << endl;
}
```



```
int f( int n )
{
    if( n <= 1 ) return 1;
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}
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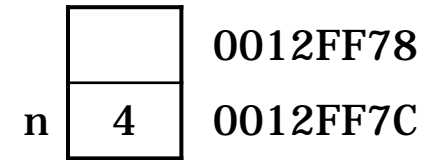


```
int f( int n )
{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
}
```

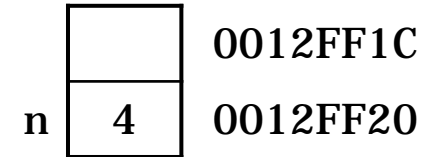
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{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
}
```

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int f( int n )
{
    if( n <= 1 ) return 1;
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}
```

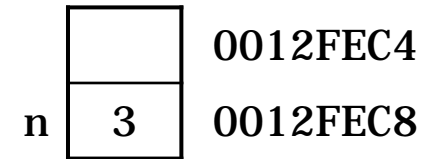
```
int main()
{
    int n = 4;
    cout << f( n ) << endl;
}
```



```
int f( int n )
{
    if( n <= 1 ) return 1;
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```
int f( int n )
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}
```

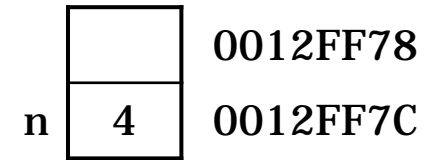


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int f( int n )
{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
}
```

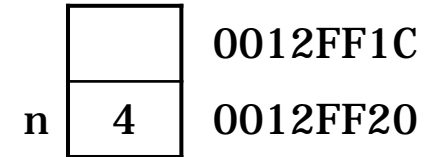
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}
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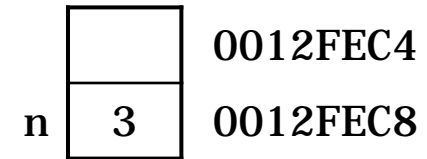
```
int main()
{
    int n = 4;
    cout << f( n ) << endl;
}
```



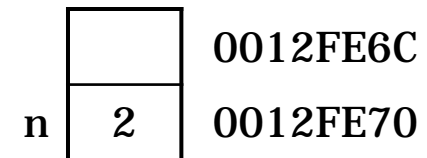
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int f( int n )
{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
}
```



```
int f( int n )
{
    if( n <= 1 ) return 1;
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}
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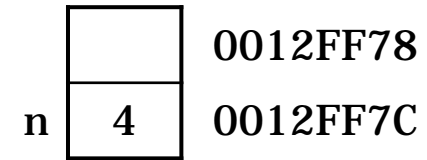


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}
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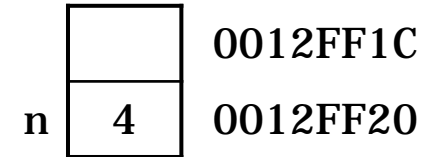


```
int f( int n )
{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
}
```

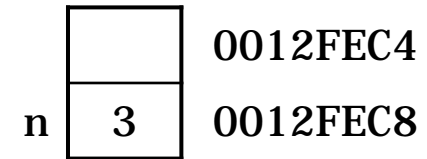
```
int main()
{
    int n = 4;
    cout << f( n ) << endl;
}
```



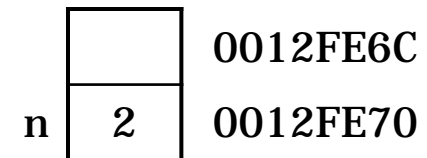
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int f( int n )
{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
}
```



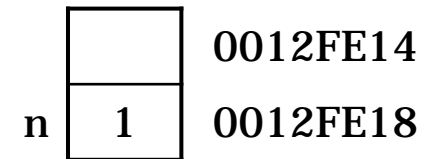
```
int f( int n )
{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
}
```



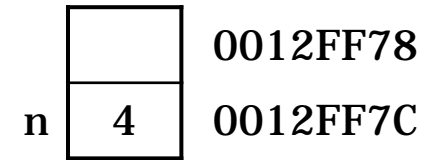
```
int f( int n )
{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
}
```



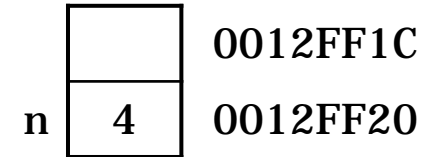
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{
    if( n <= 1 ) return 1;
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}
```



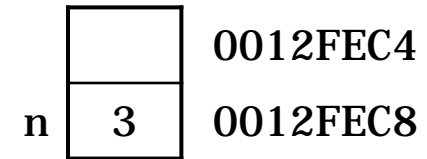
```
int main()
{
    int n = 4;
    cout << f( n ) << endl;
}
```



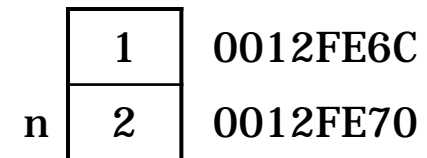
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int f( int n )
{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
}
```



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int f( int n )
{
    if( n <= 1 ) return 1;
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}
```

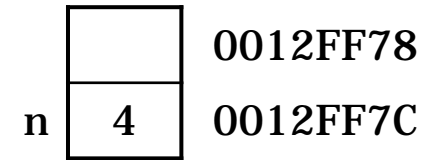


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int f( int n )
{
    if( n <= 1 ) return 1;
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}
```

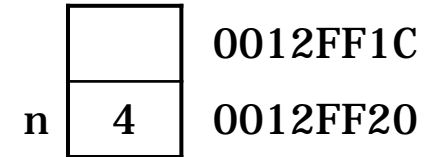


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int f( int n )
{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
}
```

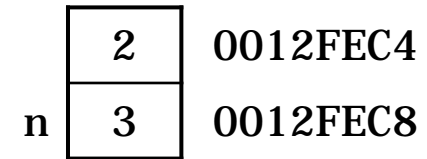
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int main()
{
    int n = 4;
    cout << f( n ) << endl;
}
```



```
int f( int n )
{
    if( n <= 1 ) return 1;
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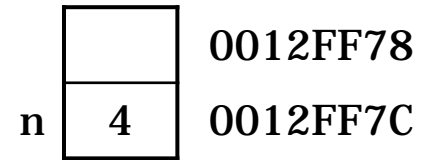
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    if( n <= 1 ) return 1;
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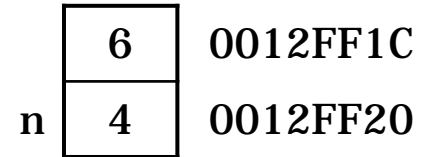
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    if( n <= 1 ) return 1;
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int main()
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    int n = 4;
    cout << f( n ) << endl;
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    if( n <= 1 ) return 1;
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}
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```
int f( int n )
{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
}
```

```
int main()
{
    int n = 4;
    cout << f( n ) << endl;
}
```

n	24	0012FF78
	4	0012FF7C

```
int f( int n )
{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
}
```

```
int f( int n )
{
    if( n <= 1 ) return 1;
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    if( n <= 1 ) return 1;
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```
int f( int n )
{
    if( n <= 1 ) return 1;
    else return n * f( n - 1 );
}
```



```

#include <iostream>
#include <iomanip>
using namespace std;

int f( int );

int main()
{
    int n = 5;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return n * f( n - 1 );
}

```

n		0012FDC4
	5	0012FDC8


```

#include <iostream>
#include <iomanip>
using namespace std;

int f( int );

int main()
{
    int n = 5;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return n * f( n - 1 );
}

```

		0012FD74
n	5	0012FD78
		0012FDC4
n	5	0012FDC8

```

#include <iostream>
#include <iomanip>
using namespace std;

int f( int );

int main()
{
    int n = 5;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return n * f( n - 1 );
}

```

		0012FD1C
n	4	0012FD20
		0012FD74
n	5	0012FD78
		0012FDC4
n	5	0012FDC8

```

#include <iostream>
#include <iomanip>
using namespace std;

int f( int );

int main()
{
    int n = 5;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return n * f( n - 1 );
}

```

		0012FCC4
n	3	0012FCC8
		0012FD1C
n	4	0012FD20
		0012FD74
n	5	0012FD78
		0012FDC4
n	5	0012FDC8

```

#include <iostream>
#include <iomanip>
using namespace std;

int f( int );

int main()
{
    int n = 5;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return n * f( n - 1 );
}

```

		0012FC6C
n	2	0012FC70
		0012FCC4
n	3	0012FCC8
		0012FD1C
n	4	0012FD20
		0012FD74
n	5	0012FD78
		0012FDC4
n	5	0012FDC8

```

#include <iostream>
#include <iomanip>
using namespace std;

int f( int );

int main()
{
    int n = 5;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return n * f( n - 1 );
}

```

		0012FC14
n	1	0012FC18
		0012FC6C
n	2	0012FC70
		0012FCC4
n	3	0012FCC8
		0012FD1C
n	4	0012FD20
		0012FD74
n	5	0012FD78
		0012FDC4
n	5	0012FDC8

```

#include <iostream>
#include <iomanip>
using namespace std;

int f( int );

int main()
{
    int n = 5;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return n * f( n - 1 );
}

```

n	1	0012FC6C
	2	0012FC70
n		0012FCC4
	3	0012FCC8
n		0012FD1C
	4	0012FD20
n		0012FD74
	5	0012FD78
n		0012FDC4
	5	0012FDC8

```

#include <iostream>
#include <iomanip>
using namespace std;

int f( int );

int main()
{
    int n = 5;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return n * f( n - 1 );
}

```

	2	0012FCC4
n	3	0012FCC8
		0012FD1C
n	4	0012FD20
		0012FD74
n	5	0012FD78
		0012FDC4
n	5	0012FDC8

```

#include <iostream>
#include <iomanip>
using namespace std;

int f( int );

int main()
{
    int n = 5;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return n * f( n - 1 );
}

```

	6	0012FD1C
n	4	0012FD20
		0012FD74
n	5	0012FD78
		0012FDC4
n	5	0012FDC8


```

#include <iostream>
#include <iomanip>
using namespace std;

int f( int );

int main()
{
    int n = 5;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return n * f( n - 1 );
}

```

	24	0012FD74
n	5	0012FD78
		0012FDC4
n	5	0012FDC8

```

#include <iostream>
#include <iomanip>
using namespace std;

int f( int );

int main()
{
    int n = 5;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return 1;
    else
        return n * f( n - 1 );
}

```

n	120	0012FDC4
	5	0012FDC8

Recursive Fibonacci Function

Let $f(n)$ be the n -th fibonacci number

$$f(n) = n \quad \text{for } n \leq 1 \quad (f(0) = 0, f(1) = 1)$$

$$f(n) = f(n-1) + f(n-2) \quad \text{for } n > 1$$

```
int main()
{
    int n;
    cout << "Enter a positive Integer: ";
    cin >> n;
    cout << "f( " << n << " ) = " << f( n ) << endl;
}
```

```
int f( int n )
{
    if( n <= 1 )
        return ;
    else
        return ;
}
```

Recursive Fibonacci Function

Let $f(n)$ be the n -th fibonacci number

$$f(n) = n \quad \text{for } n \leq 1 \quad (f(0) = 0, f(1) = 1)$$

$$f(n) = f(n-1) + f(n-2) \quad \text{for } n > 1$$

```
int main()
{
    int n;
    cout << "Enter a positive Integer: ";
    cin >> n;
    cout << "f( " << n << " ) = " << f( n ) << endl;
}
```

```
int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
}
```

```
int main()
{
    int n;
    cout << "Enter a nonnegative Integer: ";
    cin >> n;
    cout << f( n ) << endl;
}
```

0

```
int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
}
```

```
int main()
{
    int n;
    cout << "Enter a nonnegative Integer: ";
    cin >> n;
    cout << f( n ) << endl;
}
```

1

```
int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
}
```

```

int main()
{
    int n;
    cout << "Enter a nonnegative Integer: ";
    cin >> n;
    cout << f( n ) << endl;
}

```

2

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
}

```

1

0

1

0


```

int main()
{
    int n;
    cout << "Enter a nonnegative Integer: ";
    cin >> n;
    cout << f( n ) << endl;
}

```

3



```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
}

```

1

1

2

1

```

int main()
{
    int n;
    cout << "Enter a nonnegative Integer: ";
    cin >> n;
    cout << f( n ) << endl;
}

```

4

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
}

```

```

int main()
{
    int n;
    cout << "Enter a nonnegative Integer: ";
    cin >> n;
    cout << f( n ) << endl;
}

```

5



```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
}

```

3

2

4

3


```

int f( int n3 )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int 3n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 21) + f(n- 12);
}

```

```

int f( int 2n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 11) + f(n- 02);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int 1n )
{
    if( n <= 1 )
        return n;
    else 1
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```



```

int f( int 3n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 21) + f(n- 12);
}

```

```

int f( int 2n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 11) + f(n- 02);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int 1n )
{
    if( n <= 1 )
        return n;
    else 1
        return f(n- 1) + f(n- 2);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int 3n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 21) + f(n- 12);
}

```

```

int f( int 2n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 11) + f(n- 02);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int 1n )
{
    if( n <= 1 )
        return n;
    else 1
        return f(n- 1) + f(n- 2);
}

```

```

int f( int 0n )
{
    if( n <= 1 )
        return n;
    else 0
        return f(n- 1) + f(n- 2);
}

```

```

int f( int 3n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 21) + f(n- 12);
}

```

```

int f( int 2n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 11) + f(n- 02);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int 1n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int 0n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int 3n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 11) + f(n- 22);
}

```

```

int f( int 2n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 11) + f(n- 02);
}

```

```

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int 1n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int 0n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 1) + f(n- 2);
}

```

```

int f( int 3n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 11) + f(n- 22);
}

```

```

int f( int 2n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 11) + f(n- 02);
}

```

```

int f( int 1n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 11) + f(n- 02);
}

```

```

int f( int 1n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 11) + f(n- 02);
}

```

```

int f( int 0n )
{
    if( n <= 1 )
        return n;
    else
        return f(n- 11) + f(n- 02);
}

```

```

int f( int 3n )
{
    if( n <= 1 )
        return n;
    else
        return f(n-21) + f(n-12);
}

```

```

int f( int 2n )
{
    if( n <= 1 )
        return n;
    else
        return f(n-11) + f(n-02);
}

```

```

int f( int 1n )
{
    if( n <= 1 )
        return n;
    else
        return f(n-11) + f(n-02);
}

```

```

int f( int 1n )
{
    if( n <= 1 )
        return n;
    else
        return f(n-11) + f(n-02);
}

```

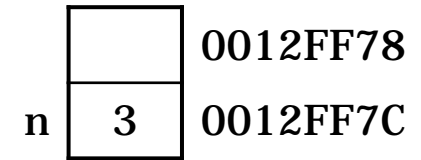
```

int f( int 0n )
{
    if( n <= 1 )
        return n;
    else
        return f(n-11) + f(n-02);
}

```



```
int main()
{
    int n = 3;
    cout << f( n ) << endl;
}
```



```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```



```
int main()
{
    int n = 3;
    cout << f( n ) << endl;
}
```

n		0012FF78
	3	0012FF7C

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FF20
		0012FF24
	3	0012FF28

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

```
int main()
{
    int n = 3;
    cout << f( n ) << endl;
}
```

n		0012FF78
	3	0012FF7C

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FF20
		0012FF24
	3	0012FF28

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FEC8
	1	0012FECC
	2	0012FED0

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

```
int main()
{
    int n = 3;
    cout << f( n ) << endl;
}
```

n		0012FF78
	3	0012FF7C

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FF20
		0012FF24
	3	0012FF28

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FEC8
	1	0012FECC
	2	0012FED0

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FE70
		0012FE74
	0	0012FE78

```
int main()
{
    int n = 3;
    cout << f( n ) << endl;
}
```

n		0012FF78
	3	0012FF7C

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FF20
		0012FF24
	3	0012FF28

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FEC8
	1	0012FECC
	2	0012FED0

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

```
int main()
{
    int n = 3;
    cout << f( n ) << endl;
}
```

n		0012FF78
	3	0012FF7C

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FF20
		0012FF24
	3	0012FF28

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FEC8
	1	0012FECC
	2	0012FED0

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FE70
		0012FE74
	0	0012FE78

```
int main()
{
    int n = 3;
    cout << f( n ) << endl;
}
```

n		0012FF78
	3	0012FF7C

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FF20
		0012FF24
	3	0012FF28

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n	0	0012FEC8
	1	0012FECC
	2	0012FED0

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

```
int main()
{
    int n = 3;
    cout << f( n ) << endl;
}
```

n		0012FF78
	3	0012FF7C

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FF20
	1	0012FF24
	3	0012FF28

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

```
int main()
{
    int n = 3;
    cout << f( n ) << endl;
}
```

n		0012FF78
	3	0012FF7C

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FF20
	1	0012FF24
	3	0012FF28

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n		0012FEC8
		0012FECC
	1	0012FED0

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```



```
int main()
{
    int n = 3;
    cout << f( n ) << endl;
}
```

n		0012FF78
	3	0012FF7C

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

n	1	0012FF20
	1	0012FF24
	3	0012FF28

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

```
int main()
{
    int n = 3;
    cout << f( n ) << endl;
}
```

n	2	0012FF78
	3	0012FF7C

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```

```
int f( int n )
{
    if( n <= 1 ) return n;
    else return f( n - 1 ) + f( n - 2 );
}
```



```

int main()
{
    int n = 3;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
}

```

n		0012FD74
	3	0012FD78

```

int main()
{
    int n = 3;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
}

```

		0012FD18
		0012FD1C
n	3	0012FD20
		0012FD74
n	3	0012FD78

```

int main()
{
    int n = 3;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
}

```

		0012FCBC
		0012FCC0
n	2	0012FCC4
		0012FD18
		0012FD1C
n	3	0012FD20
		0012FD74
n	3	0012FD78

```

int main()
{
    int n = 3;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
}

```

		0012FC14
		0012FC18
n	1	0012FC1C
		0012FCBC
		0012FCC0
n	2	0012FCC4
		0012FD18
		0012FD1C
n	3	0012FD20
		0012FD74
n	3	0012FD78

```

int main()
{
    int n = 3;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
}

```

		0012FCBC
	1	0012FCC0
n	2	0012FCC4
		0012FD18
		0012FD1C
n	3	0012FD20
		0012FD74
n	3	0012FD78


```

int main()
{
    int n = 3;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
}

```

		0012FC14
		0012FC18
n	0	0012FC1C
		0012FCBC
	1	0012FCC0
n	2	0012FCC4
		0012FD18
		0012FD1C
n	3	0012FD20
		0012FD74
n	3	0012FD78

```

int main()
{
    int n = 3;
    cout << f( n ) << endl;
}

int f( int n )
{
    if( n <= 1 )
        return n;
    else
        return f( n - 1 ) + f( n - 2 );
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n	2	0012FD74
	3	0012FD78